

**Amendments to the Specification:**

Please amend the paragraph beginning at page 1, line 10, of the specification as follows:

Research of various secondary batteries, which can be used for a long period of time and rechargeable as a power source of various electronic devices and electric apparatuses, has been made. Among others, active research and development have been made for a rechargeable lithium ion battery having characteristics such that higher energy density and higher power density can be realized in comparison with secondary batteries ~~applied as~~ commercially available such as nickel-cadmium storage batteries and nickel-hydrogen storage batteries. The rechargeable lithium ion battery is commercialized as a power source of portable electric devices such as a cellular phone, a camcorder and a laptop personal computer.

Please amend the paragraph beginning at page 1, line 21, of the specification as follows:

In addition, interest in an electric vehicle and a hybrid vehicle has been increasing so as to solve the problems of environmental pollution of the earth and greenhouse effect of the earth. Application of the rechargeable lithium ion battery as a power source of such vehicles has been expected.

Please amend the paragraph beginning at page 2, line 35, of the specification as follows:

The object of the present invention is to provide a rechargeable lithium ion battery which is capable of ~~using~~ being used as an energy source for a vehicle and improving the power density without reducing the energy density.

Please amend the paragraph beginning at page 3, line 9, of the specification as follows:

According to the first aspect of the present invention, since the particle diameter of the positive electrode active material is 5  $\mu\text{m}$  or less, the migration speed of lithium ion is not determined by diffusion of lithium ion in the positive electrode active material. Moreover, since the thickness of

the active material layer is set at a range of 20 to 80  $\mu\text{m}$ , shortage of the amount of the positive electrode active material in the thickness direction can be prevented within a range where the power density can be maintained. Also since the porosity of the active material layer is 50%, there is enough ~~amount~~ of electrolyte solution in the active material layer to prevent a decrease in the power density. As a result, the power density can be increased without reducing the energy density.

Please amend the paragraph beginning at page 5, line 13, of the specification as follows:

DETAILED DESCRIPTION OF THE EMBODIMENT INVENTION

Please amend the paragraph beginning at page 5, line 21, of the specification as follows:

Fig. 1 shows a structure example of the rechargeable lithium ion battery called a ~~jerry~~ jelly roll type. As shown in Fig. 1, a wound device in a roll fashion, which includes a positive electrode ~~10~~ 1 with a positive electrode active material coated on both surfaces of a metal foil collector (i.e. a collecting electrode), a negative electrode ~~20~~ 2 with a negative electrode material coated on both surfaces of a metal foil collector similarly, and a separator ~~30~~ 40 interposed between the both electrodes, is accommodated in a cylindrical sealing case ~~40~~ 4. An electrolyte (electrolytic solution) is filled between the positive electrode ~~10~~ 1 and the negative electrode ~~20~~ 2.

Please amend the paragraph beginning at page 5, line 31, of the specification as follows:

Other than the ~~jerry~~ jelly roll type as shown in Fig. 1, there exists a structure in which the positive electrode, the separator and the negative electrode, which are shaped in sheets, are layered in order, as the rechargeable lithium ion battery.

Please amend the paragraph beginning at page 6, line 10, of the specification as follows:

As the negative electrode active material, carbon material such as hard carbon, soft carbon, graphite and activated carbon, and metal oxide such as  $\text{SnB}_x\text{P}_y\text{O}_2$ ,  $\text{Nb}_2\text{O}_5$ ,  $\text{LiTi}_x\text{O}_y$ ,  $\text{LiFe}_x\text{N}_y$  and  $\text{LiMn}_x\text{N}_y$  can be used singly or in a mixed state. Herein, the hard carbon means ~~to~~ the carbon

material that is not graphitized when heat treatment is performed at 3000°C. The soft carbon means the carbon material that is graphitized when heat treatment is performed at a range of 2800°C to 3000°C. Note that various well known technologies can be used for manufacturing the hard carbon, such as a method using furan resin, an organic material in which oxygen is bridged to petroleum pitch having an H/C atomic ratio at a range of 0.6 to 0.8 inclusively as a starting substance. And, for manufacturing the soft carbon, a method using coal, high polymer (polyvinyl chloride resin, polyvinyl acetate, polyvinyl butylate or the like), pitch or the like as the starting material can be used.

Please amend the paragraph beginning at page 7, line 4, of the specification as follows:

As the collector, various ~~material~~ materials used in the rechargeable lithium ion battery can be used. Specifically, an aluminum foil and a copper foil are listed as the positive electrode collector and the negative electrode collector respectively.

Please amend the paragraph beginning at page 7, line 33 of the specification as follows:

As shown in Fig. 2A 2, the rechargeable lithium ion battery according to this embodiment has a positive electrode comprising a collector 30 (i.e. a collecting electrode) and an active material layer 20 formed on the collector 30. The active material layer 20 contains positive electrode active material 10. The particle diameter of the positive electrode active material 10 is set to 5  $\mu\text{m}$  or less, and more preferably to 1  $\mu\text{m}$  or less, and the thickness of the active material layer 20 is set to a range of 20 to 80  $\mu\text{m}$ , and more preferably to at a range of 20 to 30  $\mu\text{m}$ .

Please amend the paragraph beginning at page 8, line 5 of the specification as follows:

For example, the active material layer 20 is obtained by mixing various kinds of ~~component~~ components such as the positive electrode active material 10 and the binder in the solvent to make paste, coating the ~~past~~ paste on the surface of the collector 30 and drying the coated paste. When

the active material layers are formed on the both sides of the collector 30 according to a normal method, each of the active material layers is made to be an independent active material layer. Further, the particle diameter of the positive electrode active material 10 means an average particle diameter.

Please amend the paragraph beginning at page 8, line 13 of the specification as follows:

Moreover, in the rechargeable lithium ion battery the surface of the active material layer 20 substantially contacts a separator 40, and void portions in the active material layer are filled with electrolytic solution 50. The positive electrode and the negative electrode are reversibly intercalated with lithium ions. At the time of discharging the rechargeable lithium ion battery lithium ions migrate (*i.e. move*) to the positive electrode via the electrolytic solution from the negative electrode.

Please amend the paragraph beginning at page 8, line 20 of the specification as follows:

If the particle diameter of the positive electrode active material 10 is large, lithium ion diffusion in the positive electrode active material 10 particle is in a rate-determining step (*i.e. controls the rate of reaction*) at the time of discharging a large current rather than the migration of lithium ion in the electrolytic solution 50 in the electrode in the layer thickness direction of the active material layer, which is a cause for the power density reduction. Accordingly, it is preferable that the particle diameter of the positive electrode active material 10 is 5  $\mu\text{m}$  or less. Although the lowest limit value of the particle diameter of the positive electrode active material 10 is not particularly limited, 0.1  $\mu\text{m}$  or more is appropriate practically. In addition, if the thickness of the active material layer 20 is smaller than 20  $\mu\text{m}$ , the power density becomes small due to shortage of the positive electrode active material amount, which is not preferable. On the other hand, if the thickness exceeds 80  $\mu\text{m}$ , internal resistance is increased and the power density becomes small, which is also not preferable.

Please amend the paragraph beginning at page 8, line 35 of the specification as follows:

Under the condition that the particle diameter of the positive electrode active material 10 is small such that the particle diameter of the positive electrode active material 10 is 5  $\mu\text{m}$  or less, the migration of lithium ion in the electrolytic solution 40 ~~50~~ in the electrode in the layer thickness direction is considered to be in the rate-determining step at the time of discharging the large current. Accordingly, if the porosity of the active material layer 20 becomes large, the electrolytic solution amount in the electrode increases and the migration power of lithium ion in the electrolytic solution in the electrode in the layer thickness direction increases. Thus, the power density is further increased. However, if the porosity of the active material layer 20 is less than 50%, the electrolytic solution amount cannot be secured in accordance with the amount of the positive electrode active material 10. Thus the resistance increases to reduce the power density. Therefore, the porosity of the active material layer 20 is preferably 50% or more. In addition, if the porosity exceeds 60%, shortage of the amount of the positive electrode active material 10, that is, reduction of a positive electrode surface area makes the power density gradually reduced. Accordingly, the porosity is more preferably at a range of 50 to 60%.

Please amend the paragraph beginning at page 9, line 32, of the specification as follows:

The active material layer 20 may have a structure where a plurality of active material layers having ~~different porosities~~ their mean porosities positively changed to be different from other are layered. For example, as shown in Fig. 3, the active material layer 20 may have a two layer structure having active material layers 20A and 20B, each of which has a different porosity. In this case, the power density can be increased without sacrificing the energy density. Specifically, it is preferable that the porosity of the active material layer 20B closer to the separator is made larger and the porosity of the active material layer 20A closer to the collector is made smaller. The amount

of the electrolytic solution 50 in the vicinity of the separator 40 can be increased and the migration power of lithium ion can be increased by making the porosity of the active material layer 20B adjacent to the separator 40 large. Moreover, a usage rate of the positive electrode active material 10 in the vicinity of the collector 30 can be increased by making the porosity in the vicinity of the collector 30 small. Considering the above characteristics, the power density can be effectively increased by balancing the diffusion in the positive electrode active material 10 and the migration in the electrolytic solution 50. Since the energy density is influenced by an ~~average porosity~~ average of respective mean porosities of layers 20A and 20B and the active material amount of the active material layer 20, the power density can be increased without sacrificing the energy density by appropriately adjusting the average porosity and the amount of the active material. For example, an electrode having the single active material layer of the porosity of 50% and the thickness of 60  $\mu\text{m}$ , as in Fig. 2, and an electrode that consists of a layered active material layer, which has a first active material layer of the porosity of 40% and the thickness of 30  $\mu\text{m}$  closer to the collector and a second active material layer of the porosity of 60% and the thickness of 30  $\mu\text{m}$  closer to the separator, as in Fig. 3, have the equal energy density. This is because the average porosities and the amounts of the active material of the two electrodes are equal.

Please amend the paragraph beginning at page 12, line 12, of the specification as follows:

Moreover, if the particle diameter of the active material layer 21A closer to the collector 30 is 5  $\mu\text{m}$  or more, or if the active material particle diameter of the active material layer 21B closer to the separator 40 is less than 5  $\mu\text{m}$ , the effect of increasing the power density becomes small, which is not preferable. The lowest limit value of particle diameter  $r_1$  of the positive electrode active material 10A closer to the collector 30 is not particularly limited. But, it is practically appropriate that the value is 0.1  $\mu\text{m}$  or more. It is preferable that the upper limit of the particle diameter  $r_2$  of

the positive electrode active material 10B of the active material layer 20B closer to the separator 40 is appropriately selected in a range where the active material particle diameter does not become larger than the thickness of the active material layer. From the above viewpoint, the particle diameter of the positive electrode active material 10A of the active material layer 21A closer to the collector 30 is preferably 0.1  $\mu\text{m}$  or more and less than 5  $\mu\text{m}$ , and more preferably 1  $\mu\text{m}$  or more and less than 5  $\mu\text{m}$ . The particle diameter of the positive electrode active material of the active material layer 21B closer to the separator 40 is preferably at a range of 5  $\mu\text{m}$  to 20  $\mu\text{m}$  inclusively, and more preferably at a range of 5  $\mu\text{m}$  to 10  $\mu\text{m}$ .

Please amend the paragraph beginning at page 13, line 1, of the specification as follows:

In the above description, the two layer structure is mainly explained, however, the similar effect can be obtained by adjusting the porosity of the active material layer, the particle diameter of the active material and the thickness of the active material layer even if the layer structure has a multi-layer structure of three layers or more.[[.]]

Please amend the paragraph beginning at page 13, line 12, of the specification as follows:

In the rechargeable lithium ion battery of this embodiment described above, it is preferable that the positive electrode active material is lithium manganese oxide from the viewpoint of obtaining a high power density. Since manganese is much more inexpensive than cobalt and nickel and abundant as resource, it is also preferable from the viewpoint of a manufacturing cost. Specific ~~example~~ examples of the lithium manganese oxide,  $\text{LiMnO}_2$  and  $\text{LiMn}_2\text{O}_4$  are listed.